AE 321 – MECHANICS OF AEROSPACE STRUCTURES
Fall 2014

Instructor: Prof. John Lambros
Room 310 Talbot Lab
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Class Hours: Monday, Wednesday, Friday 9:00 am-9:50 am, 103 TLB

Office Hours: Monday and Wednesday 2:30 pm-4:00 pm in 310 TLB

Teaching Assistant: Mr. Korhan Sahin
Room 325 Talbot Lab
Office hours will be held in 225A TLB
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Hours: Tuesday and Thursday 3:00 pm – 5:00 pm

Course Website: https://compass2g.illinois.edu

Textbook: "Elasticity: Theory, applications and numerics",
by Martin H. Sadd, Academic Press, 3rd ed. (2014)

Notes: Course notes in the form of PowerPoint slides will be used in class for presenting the theoretical material. The slides will be posted as PDF files on the course website.
Example problems will be solved in class on the board.

Other References:

Fung, Y. C., "Foundations of Solid Mechanics", Prentice Hall, 1965.
Gurtin, M. E., "An introduction to continuum Mechanics", Academic Press, 1981.
Gould, P.L., "Introduction to Linear Elasticity", Springer, 1999
Sokolnikoff, I.S., "Mathematical Theory of Elasticity", McGraw-Hill, 1956.
Timoshenko, S., and Goodier, J. N., "Theory of Elasticity", McGraw-Hill, 1951.

Exams: Two 50 minute midterm exams (tentatively scheduled for Friday October 17, 2014, and for Wednesday November 19, 2014) and a final exam (8:00-11:00 AM, Monday December 15) will be held. All exams will be **closed book and closed notes** and the material covered in each is **cumulative** from the beginning of the semester. An equation sheet will be provided in each exam and **calculators will not be allowed**.

Homework: Graded homework will be assigned roughly once a week. Although the homework will be graded (see below), the homework exercises should also be viewed as a learning tool to help you understand the material. It is impossible to master the material in the course without being in a position to solve a large proportion of these problems. In that sense, your success in the course will depend highly upon your completing these exercises. Your chances of success in the exams will increase drastically if you do the homework on a regular basis. If you feel you need additional practice beyond the exercises handed out, you should try to solve additional problems that can be found in the various textbooks listed above. Solutions to the exercises will be posted on the web after the homework is handed in. These solutions are also a learning tool and you should refer to them after having attempted the relevant exercises.

Grading:

Homework: 10%
Midterm exams: 20% each
Final exam: 50%

Final grades will be allocated using the above percentages. A plus/minus scale will be used, although there is no grade curving.

Lab demo: There will be one laboratory demo (probably around week 8 or 9). This will involve observation of a tensile testing procedure. A set of homework exercises will be based on the results obtained during the lab demo.

Objectives: This course is designed to introduce students to the fundamental concepts of elasticity, such as stress, strain, equilibrium, compatibility, material response and failure, and to allow students to solve Boundary Value Problems of elastic materials subjected to applied traction and/or displacement loading. The specific objectives of this course are for the students to be able to:

(a) manipulate tensorial quantities through the use of the tensor transformation equations and indicial notation,

(b) identify and compute the properties and components of stress and strain fields including principal values, principal directions, normal and shear components etc.,

(c) realize the physical meaning of stress-strain curves and the relationship between stress and strain in an elastic material, as well as the concepts of inhomogeneity, anisotropy and viscoelasticity,

(d) solve Saint-Venant type boundary value problems involving extension, bending and torsion, and planar boundary value problems including plane stress and plane strain.

(e) calculate failure points for engineering systems and design according to failure criteria such as Tresca and Von-Mises, and Miner's rule in Fatigue.

Course Outline

WEEK	TOPIC
1	**Mathematical Preliminaries:** indicial notation,
	vector and tensor definitions, operations,
2	divergence, gradient and curl.
	Traction, Stress, Equilibrium: traction vector,
3	stress tensor and stress components, equilibrium,
4	principal stresses and directions, Mohr's circle.
5	**Deformations (strain):** strain, compatibility,
6	physical interpretation, finite strains.
7	**Material Behavior:** uniaxial material behavior,
	generalized Hooke's law, material symmetry and anisotropy,
8	composite materials, viscoelasticity, yield.
	EXAM #1 9:00-9:50 AM Friday October 17, 2014
9	**Problem Formulation and simple solutions:** superposition,
10	St. Venant's principle, bar under uniaxial load, beam bending
11	beam torsion
12	**Strength and Failure**
	Tresca and Von Mises criteria for yield, failure and fracture,
	fatigue.
13	**Plane problems (2D Elasticity):** plane stress, plane strain
	EXAM #2 9:00-9:50 AM Wednesday November 19, 2014
14	THANKSGIVING RECESS
15	Airy stress potential, thick walled cylinders,
	shrink fit cylinders, stress concentration at a hole.
16	COURSE REVIEW.
	FINAL EXAM 8:00-11:00 AM, Monday December 15, 2014